The National Space Grant Office requires two annual reports, the Annual Performance Data Report (APD – this document) and the Office of Education Performance Measurement System (OEPM) report. The former is primarily narrative and the latter data intensive. Because the reporting timeline cycles are different, data in the two reports may not necessarily agree at the time of report submission. OEPM data are used for official reporting.

Utah Space Grant Consortium
Lead Institution: University of Utah
Director: Dr. Joseph Orr
Telephone Number: 801-573-2091
Consortium URL: http://www.utahspacegrant.com/
Grant Number: NNX10AJ77H

PROGRAM DESCRIPTION

The National Space Grant College and Fellowship Program consists of 52 state-based, university-led Space Grant Consortia in each of the 50 states plus the District of Columbia and the Commonwealth of Puerto Rico. Annually, each consortium receives funds to develop and implement student fellowships and scholarships programs; interdisciplinary space-related research infrastructure, education, and public service programs; and cooperative initiatives with industry, research laboratories, and state, local, and other governments. Space Grant operates at the intersection of NASA's interest as implemented by alignment with the Mission Directorates and the state's interests. Although it is primarily a higher education program, Space Grant programs encompass the entire length of the education pipeline, including elementary/secondary and informal education. The Utah Space Grant Consortium is a Designated Consortium funded at a level of $575,000 for fiscal year 2014.

PROGRAM GOALS

Outcome 1: To demonstrably contribute to the development of the STEM Workforce with programs, projects and activities that are in direct alignment with NASA's stated education strategic goals, missions and with her defined outcomes, objectives and PART measures.

SMART Objectives:

1: Increase the percentage of our Space Grant Fellowships and Scholarships given to female students from an average of 32% in 2005-2009 to 40% in 2010-2014. Increase the percentage of awards to minority students from an average of 27% in 2005-2009 to 30% in 2010-2014. This will maintain greater diversity in our Space Grant program compared to the demographics of the State, where 23% of the students are female and 13% are minorities. This will keep our percentages well above the NCES Digest Statistics, where 22% of the students are female and 11% are minorities.

2: a) Improve the process throughout the Consortium by which Fellowships are announced, applications solicited, applications competitively reviewed, awards made,

administered and tracked. Our Consortium web site will be revised to have application links from each of the three research universities: U of U, BYU, and USU, so that student applicants can see the specific requirements set forth from these three affiliate institutions. b) From 2005-2009 we awarded an average of 22 Fellowship awards each year. In 2010 we plan to award 17 Fellowships at the graduate student level. All of these awards will be above $5,000 tracking level. The number of Fellowships awarded in 2010 is less than in 2009 due to the total Space Grant funding in 2010 being $575 K rather than $785 K in 2009. c) From 2005-2009 students and faculty published an average of 34 scientific reports each year. From 2010-2014 we plan to publish an average of 34/year.
3: Each year target at least three project areas to focus Space Grant interdisciplinary research and development selected from [1] space systems engineering (ESMD-spacecraft), [2] life support in space (SOMD-crew health, safety, medical ops), [3] space vehicle propulsion (ESMD-propulsion), [4] remote sensing by optical, infrared and microwave imaging (SOMD-space comm.) in direct alignment with NASA Enterprise priorities.
4: From 2005-2009 we awarded an average of 25 undergraduate Scholarships each year. From 2010-2014 we plan to award 29 Scholarships at the undergraduate level each year. Of these awards, 8 will be above $5,000 and 11 will be below the $5,000 tracking level.
5: Increase the number of research infrastructure minigrants awarded to junior faculty members of our Consortium as an investment in their space-related research and career development. From 2005-2009 we made an average of 2 awards. In 2010 we plan to make at least 5 awards to junior faculty members.
6: In 2010 we proposed to fund 11 student internships each year at NASA Centers. In 2012-2014 we propose to award four student internships each year (stipend plus round trip travel) to participate in summer research at NASA centers.
7: From 2005-2009 7% of our Space Grant students graduated with STEM degrees and entered the STEM workforce. From 2010-2014 we plan on 9% of our students graduating with STEM degrees and starting their careers in the STEM Workforce. From 2005-2009 16% of our Space Grant students graduated with bachelor degrees and entered graduate school declaring a STEM major. From 2010-2014 we plan on 18% of our students graduating with degrees and entering advanced degrees declaring a STEM major.
Outcome 2: To attract and retain students and teachers in the STEM disciplines who have a solid understanding of the subject material.
SMART Objectives:
8: From 2005-2009 we conducted an average of 9 teacher career development workshops each year. From 2010-2014 we plan to conduct 10/year.
Outcome 3: Conduct an Informal Education program to form strategic partnerships and linkages between STEM formal and informal providers leading to an expansion of the nation's future STEM workforce through awareness of the mission of NASA and the promotion of STEM literacy.
SMART Objectives:
9: From 2005-2009 we supported the activities of 3 informal STEM education partnership collaborative projects each year. From 2010-2014 we plan to support 4 informal educational collaborative projects each year.

10: Annually develop 4 sets of informal education standards-based STEM materials to enrich visual and activity experiences by informal education providers. Support satellite facilities that make this material available to teachers.

Management:

SMART Objective:

11: Provide one single point of contact for our consortium, namely Dr. Joseph Orr, Director/PI. Our Education Administrator and Program Coordinator will report directly to Dr. Orr and help facilitate all consortium activities, including reporting, proposal preparation, and responding to NASA's requests.

PROGRAM/PROJECT BENEFIT TO OUTCOME (1,2, and 3)

Outcome 1. Development of STEM Workforce

NASA Space Grant funds have supported the research of Brigham Young University graduate fellowship student, Carla Carroll. Carla has been performing research at BYU using a planet-hunting satellite to observe a supermassive black hole. Many of the ground-based observations were performed at BYU's West Mountain Observatory, the largest research observatory in Utah. "Using measurements that were done at BYU, we were able to determine that the mass of the central black hole for this galaxy was about 8 million times the mass of the sun -- that's a really, really massive object," said Professor Michael Joner. Joner and Carroll used reverberation mapping to analyze time difference and measure how fast the material is moving around the center of the galaxy to determine the mass of this central black hole. "The best part of this project for me was learning about active galactic nuclei and supermassive black holes on a level I never could have in either undergraduate or graduate classroom settings," Carroll said. Carroll will graduate in April 2015 with a Master of Science. She recently earned admission to the University of Heidelberg in Germany for a Ph.D. program in astrophysics.

The UNSGC supported Marcus Ritter, undergraduate student at Utah State University studying mechanical and aerospace engineering, on an internship to the NASA Jet Propulsion Laborataory (JPL) for the summer of 2014. Marcus had the opportunity to work on a technology development project. He participated on a team that built a half-scale model of the Starshade, which is a satellite that will work with a telescope satellite to block out the light of a star which results in the ability to directly image a planet that is orbiting that star to help find habitable planets. Upon completion of his successful internship, Marcus stated: "My time with JPL really helped me fine tune what I want to do. I now want to go into spacecraft design and/or systems engineering for spacecrafts. This internship provided me with lots of hands-on experience and truly understanding what types of tolerances are possible and what 0.001 inches really feels like. Because of my time at JPL I would love to end up working there. I should be going back there this summer (2015) for another internship and possibly future employment after my masters." A link to a youtube video showing work Marcus and his team performed can be found at: https://www.youtube.com/watch?v=Ttnvx1INanQ

Outcome 2. Attract and retain students and teachers in the STEM disciplines

Utah has implemented a precollege meteorite program. Excitement and interest are high in a kindergarten or 1st grade classroom when a 12-pound meteorite is passed around that

the students can touch and experience. The weight of the meteorite is compared to another one-pound igneous rock of about the same size. The hands-on approach of this meteorite program has been successful with teachers and students in the state because the students are encouraged to hold, handle, and have close contact with the individual items. At the present time, we have 12 sets of these three geological items which have been strategically placed in six of the largest school districts, museums, universities, four-year and junior colleges, and a planetarium. We are keeping track of the thousands of teachers and students this program is reaching and disseminating materials they can learn about in their classrooms on this subject. In FY 2014, the meteorites have reached over 80,000 students and 3,200 teachers.

PROGRAM ACCOMPLISHMENTS

Outcome 1: Development of STEM Workforce

SMART Objectives:

1. During FY 2014 we awarded 37 fellowships and scholarships. Twenty-one of these were awarded to female students (56.8%) and 19 were awarded to minority students (51.4%). We were above our base funding goal of 40% for female students and above our base funding goal of 30% for minority students.

2. a) We have continued to utilize the new website for the Utah Space Grant Consortium for fellowship and scholarship applications for each of our three research universities. The applications were implemented to standardize the application process and to make students aware of the requirements and stipulations involved with the fellowship/ scholarship awards. A review board at each affiliate institution reviews and selects the award recipients. Awards are made, administered, and tracked by each individual affiliate and our Program Coordinator works with each affiliate regularly to maintain the database of all awards and student information to feed into the longitudinal tracking system of the Education Program Support Services (EPSS). b) In FY 2014, we awarded 19 graduate fellowships (10 PhD, 9 MS) with base Space Grant funding, thus exceeding our objective to use base finding to provide 17 graduate fellowships. All of the 19 graduate fellowship awards were considered significant in the longitudinal tracking system due to receiving ≥$5,000 award and/or spending 160 hours or more. c) A total of 55 papers were submitted to professional journals, conferences and symposia, or published by our students. Our target was 34 papers per year so we have exceeded our goal. Twenty-four papers are being published in the Proceedings of the 21st Annual Utah Space Grant Graduate Fellowship Symposium plus a total of 31 professional paper and conference submittals were made to professional journals and institutes appropriate to the relevant scientific or engineering specialty.

3. When awarding fellowships and scholarships, improving research infrastructure, and advertising higher education project opportunities, we targeted all four areas of interdisciplinary research and development proposed. The University of Utah targeted life support in space; Utah State University targeted space vehicle propulsion and space systems engineering; Brigham Young University targeted space systems engineering and remote sensing by optical, infrared and microwave imaging. We exceeded our objective of targeting three areas by focusing on all four areas of research.

4. We awarded 18 undergraduate scholarship awards in FY 2014. This did not meet our original goal to award 29 undergraduate scholarships. Due to decreased funding in FY 2014 (no augmentation funds at the time of this reporting), we did not place as much

emphasis on undergraduate scholarships in FY 2014. Of these 18 undergraduate scholarship awards, none were above the $5,000 tracking level or minimum hours requirements and were therefore, not included in the longitudinal tracking system. Although not longitudinally tracked, we consider our annual awards of multicultural scholarships to be unique in that in some cases it helps the students to stay in school and continue their education in the STEM fields.

5. Three research infrastructure minigrant awards were awarded during FY 2014 as follows: (1) "Preservation of DNA in Ancient Halite as a Biomarker for Potential Life in Space," Dr. Bonnie Baxter, Westminster College; (2) "Extracting Geometric Information from Convolutive Blind Source Separation for Seismic Subsurface Exploration," Dr. Todd Moon, Utah State University; and (3) "Droplet Mobility in Superhydrophobic Channels," Dr. Julie Crockett/Dr. Brian Iverson/Dr. Daniel Maynes, Brigham Young University. Therefore, we were below our goal of awarding five research infrastructure minigrant awards for FY 2014. This is due to the fact that we awarded a higher dollar level to each project out of our budgeted funds in this category this year.

6: We have budgeted and are planning to use FY 2014 funding to support three interns at NASA Centers during the summer of 2015. At the time of this submission, we have only received one application to consider for funding for summer 2015 internships. However, we expect several from OSSI, LARSS, or NASA Academy to be received in March 2015 to review and endorse. After our review of these applications, we will fund three students for summer 2015 internships. Our goal was to fund four interns per year, however due to limited funding in FY 2014 and a higher stipend than we had budgeted for, we are only able to support three interns during the summer of 2015. The internships being funded include stipends of $6,000 each.

7: Twelve of our fellowship students made their next career steps in FY14 (SG participation supported from FY06-FY14 funds). Three students are pursuing advanced degrees in STEM disciplines, one student accepted a STEM position at a NASA contractor, two students accepted STEM positions in industry, three students accepted STEM positions in academia, and three students went onto positions in non-STEM disciplines.

Outcome 2: Attract and retain students and teachers in the STEM disciplines
SMART Objectives:

8: We have conducted six teacher workshops and plan an additional five teacher workshops using FY 2014 precollege funds making a total of 11 teacher workshops in FY 2014. These workshops were held or are being planned at the following school districts: Salt Lake City, Jordan, Granite, Cache, Alpine, Granite, Jordan, Washington, Weber, Ogden, and Box Elder. The total number of workshops performed during FY 2014 will be 11 which exceeds our goal of conducting 10 workshops/year during the 2010-2014 award period.

Outcome 3: Informal Education program to form strategic partnerships/linkages
SMART Objectives

9: New informal education partnerships were established with (1) American Indian Services (AIS) headquartered in Provo, Utah; (2) STE^{2}M (Science, Technology, Engineering, Education, and Mathematics) Center on the Utah State University Campus;

(3) Experimental Sounding Rocket Association (ESRA) annual rocket competition held at Green River, Utah; and (4) MESA/STEP program at the University of Utah which is a statewide consortium of higher education institutions, businesses and industry, public school districts, community organizations and government agencies. We facilitated our goal of four new STEM informal education partnerships this past year as stated in our objective.

10: We developed and distributed four sets of educational materials on-line and in hard copy. We met our objective to develop and distribute four sets of STEM educational materials. These educational materials covered the subjects of: (1) plate tectonics, (2) astronomy, (3) solar system, and (4) geological time. Each of these four areas are also targeted in a majority of our science teacher workshops and teachers are given sets of educational materials in handout form, on-line and in real-world objects in these areas to take back to their classrooms for implementation as they teach.

Management SMART Objective

11: The organizational structure of the consortium has continued to have one Space Grant/EPSCoR Director/PI who manages the operations of the Utah NASA Space Grant Consortium.

PROGRAM CONTRIBUTIONS TO NASA EDUCATION PERFORMANCE MEASURES

- **Diversity**: Our Consortium changed our goal in FY 2011 to increase diversity by targeting more awards to female and minority faculty and students. We have continued this effort in FY 2014 to maintain the same goals set forth. All of our research universities (University of Utah, Brigham Young University and Utah State University) allocated a certain portion of fellowship/scholarship and higher education funding toward this effort. This has resulted in percentage of females awarded and percentage of minority participants to both be above our goal in our reporting this year. During FY 2014 we awarded 37 fellowships and scholarships. Twenty-one of these were awarded to female students (56.8%) and 19 were awarded to minority students (51.4%). Utah's largest minority sub-population is Hispanic (13% according to 2010 census). In FY2014, we funded 12 Hispanic students (32%) which is a 11% increase from last year as we targeted this group in Utah.
- **Minority-Serving Institution Collaborations:** There are no designated minority-serving educational institutions in Utah. However, Weber State University and Salt Lake Community College have large Hispanic student populations with whom we have joint activities.

NASA Education Priorities:

- **Authentic, hands-on student experiences in STEM.** The Utah Space Grant Consortium places high priority on giving students hands-on opportunities to do research projects. These students are funded through our fellowships and scholarships, higher education and research infrastructure programs. An example of a hands-on student experience in STEM in FY2014 follows: "Involvement with the Space Grant program was very important in opening my eyes to cool things that are done in the aerospace industry and helped lead me to an internship with a

defense contractor where I was involved in modeling reliability for different weapon systems. This past summer I had an internship with Northrop Grumman as a technical intern where I was involved with projects modeling the reliability of ground based interceptors for the GMD missile program and projects dealing with ICBMs." (David Coats - on 09/22/14, 2014 Space Grant Fellowship)

- **Engage middle school teachers in hands-on curriculum enhancement capabilities through exposure to NASA scientific and technical expertise.** The outreach program of the UNSGC has provided several hands-on curriculum enhancement experiences for in-service middle school teachers in FY 2014. These curriculum enhancement experiences included meteorites, plate tectonics, astronomy, the solar system, and geological time. Educational materials were developed and distributed to over 200 middle school teachers in FY 2014.
- **Summer opportunities for secondary students on college campuses with the objective of increased enrollment in STEM disciplines or interest in STEM careers.** Westminster College hosts the AWE+SUM (Attend Westminster, Explore Science, Use Math) camp for girls entering the 8^{th} grade in the fall. This camp conducted by math and science (female) faculty endeavor to get the girls excited about math, physics, chemistry, biology, computer science and aviation through hands-on workshops. The Empowering Your Tomorrow (EYT – targets 6^{th} – 12^{th} grade boys) and Expanding Your Horizons (EYH – targets 6^{th} – 12^{th} grade girls) conferences are held annually on the campus of Utah Valley University. The purpose of these conferences is to introduce students to a variety of career choices to inspire them to seek higher education and to graduate from college.
- **Community Colleges.** Our consortium has three community college affiliates: Salt Lake Community College, Snow College and Utah College of Applied Technology (UCAT). In FY 2014, Space Grant funds were distributed to these affiliates and they were involved with higher education and precollege programs at their institutions to expand opportunities for students in the STEM fields. We have been able to further develop our relationship with these partners through the awarding of the community colleges/technical colleges funding that came as a separate NASA grant in FY 2014. This opportunity has strengthened the involvement of these community college/technical school affiliates in our Consortium.
- **Aeronautics research**. Blaine Harker, graduate fellowship student, performed research in conjunction with NASA Langley Research Center to improve sophisticated techniques for array measurement of jet noise. "This school year, I have been able to present on aeroacoustics topics pertinent to full-scale aircraft at the Acoustical Society of America (ASA) meeting in Indianapolis, Indiana, and I have plans to present at ASA Pittsburgh, Pennsylvania this upcoming May. In this work, I have the opportunity to collaborate with some well-known names in the air and space industry, both through my mentorship with Kent Gee and Tracianne Neilsen, as well as networking and collaboration opportunities with well-known researchers in my discipline. I have previously visited and collaborated in ongoing research, particularly with Chris Bahr at NASA Langley, providing future opportunities in collaboration and potential employment after graduation." (Blaine Harker - on 02/13/15, 2014 Space Grant Fellowship, Dept. Physics & Astronomy)

- **Environmental Science and Global Climate Change**. Utah Space Grant supported two Brigham Young University graduate students in FY 2014 who were doing their research in the areas of environmental science and global climate change. Alexandra Ahern performed research on the analysis of paterae and mountains: spatial relationships, geomorphology, and implications for global processes. David Coats studied sea-level change on the East coast with spatiotemporally correlated data.
- **Enhance the capacity of institutions to support innovative research infrastructure activities to enable early career faculty to focus their research toward NASA priorities**. We continue to support innovative research infrastructure activities by advertising funding for minigrants among the educational institutions in the state. In FY 2014, we awarded: (1) "Preservation of DNA in Ancient Halite as a Biomarker for Potential Life in Space," Dr. Bonnie Baxter, Westminster College; (2) "Extracting Geometric Information from Convolutive Blind Source Separation for Seismic Subsurface Exploration," Dr. Todd Moon, Utah State University; and (3) "Droplet Mobility in Superhydrophobic Channels," Dr. Julie Crockett/Dr. Brian Iverson/Dr. Daniel Maynes, Brigham Young University.

IMPROVEMENTS MADE IN THE PAST YEAR

In 2014, the Utah NASA Space Grant Consortium made an improvement to the way we award research infrastructure projects. We wrote an internal call for proposals for this opportunity and advertised it to all of the higher education affiliates of our Consortium. Affiliates were able to propose for these competitive funds versus having it allocated to the research universities in the past. The intent of the UNSGC Faculty Research Infrastructure Award Program is to develop interdisciplinary research projects with UNSGC seed funding to build a sustainable capability in the state which supports NASA's mission. This change has resulted in improved reporting and data from our research infrastructure funds and we were able to support more students in this area.

UNSGC has continued to target improved communication among Space Grant affiliates by keeping them informed of upcoming opportunities, events, and activities. We have been working more closely with our university internal offices, refining our invoice review process of subcontracts, and working more closely and effectively with grants and contracts accounting and sponsored programs offices at our lead institution, namely the University of Utah. We are improving our annual meeting of Trustees held each May starting with our upcoming meeting on May 12, 2015. Affiliate feedback suggests more topics on the agenda for collaboration and interaction. We plan to have all affiliates send in a report of what they have done over the past year and distribute for review ahead of the meeting. We are implementing a new agenda where we will solicit topics for discussion and interaction after the usual business part of the meeting is conducted.

PROGRAM PARTNERS AND ROLE OF PARTNERS IN PROJECT EXECUTION

PhD Granting Research Universities: Fellowships, Scholarships, Internships, Higher Education and Research Infrastructure projects

(1)University of Utah; (2) Utah State University; (3) Brigham Young University

Industry: Aerospace, defense and commercial products industrial partner
(4) Orbital ATK

Education Institutions: Higher Education, Research Infrastructure, and Precollege projects
(5) Weber State University; (6) Southern Utah University; (7) Snow College; (8) Dixie State University; (9) Utah College of Applied Technology; (10) Salt Lake Community College; (11) Westminster College; (12) Utah Valley University

Government Centers: Government partners, internship opportunities
(13) Idaho National Laboratory; (14) Space Dynamics Laboratory; (15) Hill Air Force Base

Outreach Institutions: Precollege and informal education programs and projects
(16) Clark Planetarium; (17) Hill Aerospace Museum; (18) North American Native Research & Education Foundation; (19) The Leonardo